Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

VOLUME XXV NUMBER 4

THE
JOURNAL OF GEOLOGY

*MAY-JUNE 1917*

# LABIDOSAURUS[1] COPE, A LOWER PERMIAN COTYLOSAUR REPTILE FROM TEXAS

SAMUEL W. WILLISTON
University of Chicago

Although remains of the genus *Labidosaurus* are not rare in the upper Clear Fork beds of Texas, it has only been lately that fairly complete skeletons have been secured. During the past season Mr. Paul C. Miller was fortunate in finding, not far from the paleontologically famous Craddock Ranch, near Seymour, Texas, some half-dozen specimens, associated in a spot but a few square yards in area—specimens which furnish nearly every detail of the skeletal structure, excepting, as usual, the length of the tail. These specimens come from a horizon that I have several times mentioned, that from which the connected skeletons of *Seymouria* and *Trimerorhachis*, previously described, were obtained. Like those, these skeletons were inclosed in hard clay nodules of a mottled red and white color. The bones are rather soft and white in color, while the matrix is very hard, making their preparation difficult.

---

[1] *Labidosaurus* Cope, *Proc. Amer. Phil. Soc.*, 1896, p. 185; Case, *Zoöl. Bull.*, II (1899), 231 (*Pariotichus*); *Revision of the Cotylosauria* (1911), 45, 101; *Permocarboniferous Beds of North America, and Their Vertebrate Fauna*, p. 137, 1915; Broili, *Paleontographica*, XI (1905), 51; Williston, *Jour. Geol.*, XVI (1908), 359; *ibid.*, XXII (1914), 65; *ibid.*, XXII (1914), 414; *Contributions from Walker Museum*, I, No. 8 (1914), 157; *ibid.*, No. 9 (1916), 221; Branson, *Jour. Geol.*, XIX (1911), 136; v. Huene, *Bull. Amer. Mus. Nat. Hist.*, XXXII (1913), 351.

The most important of these specimens (No. 174 Fig. 1), that upon which the restoration (Fig. 8) chiefly is based, includes the right half of the skull, the connected series of vertebrae and ribs to the base of the tail, the pectoral girdle, the humerus, the radius, the ulna, a single metacarpal, the pelvis, seen from below, and the right hind leg complete, except the phalanges of the fourth and fifth toes. Another specimen (No. 177) comprises the skull, a complete series of closely articulated vertebrae and ribs to the second sacral, the clavicular girdle in place, a part visible of the left scapula, the left front leg, with the exception of most of the phalanges, a femur, and part of the pelvis. This specimen has been laid bare on the ventral side. A third specimen (No. 176) has the skull with its upper part largely destroyed, the series of vertebrae and ribs nearly to the sacrum, the pectoral girdle, both humeri, one forearm, and part of the hand. The fourth specimen (No. 178) comprises a complete skull, the connected vertebrae to about the middle of the back, and the connected pectoral girdle. The other specimens are more fragmentary and have not yet been prepared.

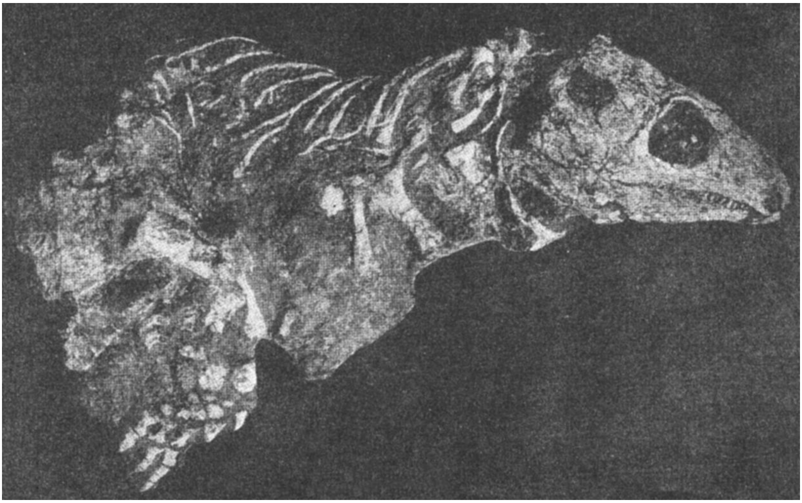

FIG. 1.—*Labidosaurus.* Specimen No. 174, as prepared. One-fourth natural size.

In addition to these specimens preserved in their matrix, there are eight other more or less complete skulls, as many more incomplete, and numerous series of vertebrae, girdles, and limb bones—altogether about thirty specimens. The material, it will be seen, is ample to determine the skeletal structure.

In size, these specimens vary not a little. About half of them are of nearly uniform size, the skull measuring seven inches along the median line; these clearly all belong to the type species *L. hamatus* Cope. Four other skulls, including the one originally described by Case and myself as *Labidosaurus* (*Pariotichus*) *incisivus* (No. 634) and Nos. 174 and 178 measure five inches along the midline. All of these, unless it be No. 634, come from the upper Clear Fork horizon. Two other skulls, and parts of others, including the maxillae in which the additional maxillary teeth were observed, are of smaller size, measuring only four inches. Two of these (180 and 183) come from a much lower horizon, that which has yielded most, if not all, the known specimens of *Pantylus*. They have but a single row of teeth in the mandibles, and have the long premaxillary teeth, and cannot be placed in the genus *Captorhinus*, though they differ materially from the large skulls in having the face less compressed. Probably they will eventually find a place in another yet unnamed genus. The most important of these is a very perfect specimen (No. 183) herewith figured (Fig. 2). In each orbit there is preserved a part of a sclerotic ring, the earliest appearance, I believe, of such ossifications in a reptile. The separate plates (Fig. 3) are narrow, with a flattened, thumblike projection on each extending over the adjoining plate near its inner end; otherwise they are not imbricated. In specimen No. 174 fragments of similar plates are preserved in the orbit. Doubtless all the members of this group had similar ossifications of the sclera, and it is not at all improbable that most Paleozoic reptiles possessed them.

*Skull.*—Nearly every detail of the skull of *Labidosaurus* is known with assurance, owing to the combined researches of Cope, Broili, Case, and myself. In the first figure of the skull given by me, the quadratojugal was given as a distinct bone, and also a division of the squamosal into two bones. In my second figure the quadratojugal was omitted as doubtful, as was also the supratemporal. I thought that I found in two specimens a suture separating the posterior part of the squamosal, and recognized it as the "epiotic," following Cope. A skull acquired very soon thereafter showed clearly that there was no such suture, and that the ascription of a tabular was an error, as recorded by Branson (*op. cit.*). The sutures given in the present figures have been corroborated in at least a dozen skulls, and there can no longer be any doubt about them.

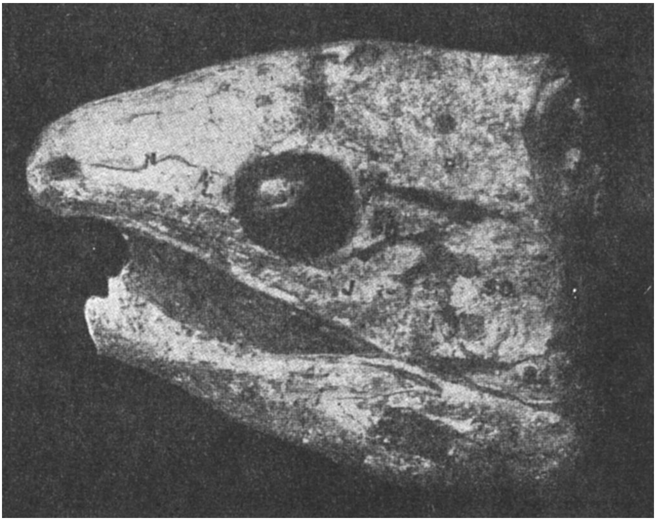

FIG. 2.—*Labidosaurus*(?). Skull, from the side. Three-fourths natural size. No. 183.

The figure given by v. Huene (*op. cit.*), I regret to say, has a number of inaccuracies. There is a distinct quadrotojugal, a bone found in nearly all the American Permocarboniferous reptiles; there is no supratemporal, absent also in *Procolophon* and *Captorhinus;* and no tabular, present in all other cotylosaurs, and in many theromorphs. Of the structure of the under side of the skull I have no corrections to make of my earlier figures. In none of the large specimens is there a trace of the parasphenoid; it is certainly absent in some; in two of the smaller skulls it is present though small. Perhaps its absence is a generic or a specific character. Nor have I any changes to make in my figures of the occipital region. The paroccipital exists as a distinct bone. The proötic, epipterygoid, and the relations of the quadrate are as I have described and figured them. The small bones above the brain case, which I doubtfully called the "alisphenoids," in the doubt now existing as to the presence of the mammalian alisphenoid in the reptiles may be called the "postoptics," the name first proposed for them by Cope. Nor have I any emendations to make of the structure of the mandible as figured by me.

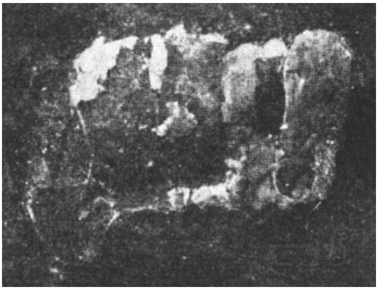
FIG. 3.—*Labidosaurus.* Sclerotic plates. Enlarged.

Whether all the forms have additional teeth on the inner side of the maxillae posteriorly I cannot say since in most specimens the mandibles are tightly closed, precluding an examination of this region. Two smaller maxillae, as recorded by Branson, possess them. The premaxilla has, in most specimens, three teeth, of which the first is the largest, and the third small. Case has based a species, *L. broilii*, on the presence of two elongated premaxillary teeth, but I think that the character is variable. The number of teeth in the maxilla also is variable. In the earlier specimens I could find not more than seventeen or eighteen. In that herewith figured (No. 174) there are twenty-four, the posterior ones quite small. Whether this difference is a specific or an individual character I am not prepared to say. I am unwilling to give specific names until I am assured that I know specific characters, and such we do not know well in any genus from the American Permian—in general I am skeptical of the "species" of all fossil reptiles.

Nearly every skull of *Labidosaurus* hitherto found was fossilized in a horizontal position and it has been exceedingly difficult to determine the amount of depression they had suffered. Among the numerous skulls now at my command there are two only which have not thus been distorted. One, an unusually large skull measuring eight inches in length, shows very little if any distortion. The other, that herewith figured (Fig. 1), had been evenly split along the

Vol. 25 11

median line and the right half has been preserved in articulation with the vertebrae lying upôn its side. In this specimen, the slight distortion is in the other direction; its height posteriorly is a little too great. From a study of all these specimens, however, one can determine almost exactly the elevation of the posterior part of the skull, about as I have figured it in the restoration. Whence it follows that in all the figures hitherto given, including my own, the skull is shown too much flattened posteriorly, and the orbits too ovate in form when seen from the side. In reality the orbits seen from the side are almost circular in outline.

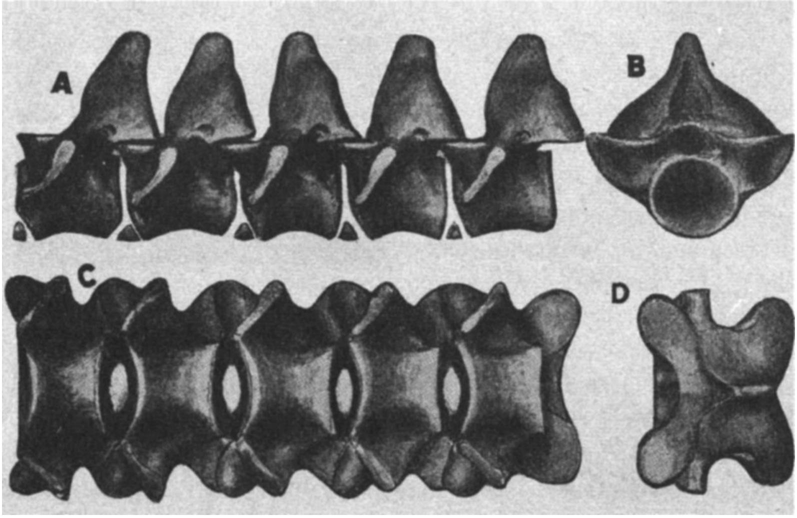

FIG. 4.—*Labidosaurus*. Anterior dorsal vertebrae. *A*, from the side; *B*, from in front; *C*, from below; *D*, from above. Natural size.

*Vertebrae.*—The peculiar structure of the vertebrae, which *Labidosaurus* shares for the most part with *Captorhinus*, has been described sufficiently well by Case, and will be seen from the accompanying figure (Fig. 4). Vertebrae of this type are known exclusively from the Texas deposits, with one exception, a specimen of a large form found by Professor Case in the El Cobre Cañon. I believe that when the skull of this genus is discovered it will prove to be of the *Labidosaurus* type. I may add that the horizon of this specimen is rather high up in the Cobre deposits.

The atlas cannot be made out in any of the connected specimens. Doubtless there is also a proatlas. The axis scarcely differs from the following vertebrae. There are twenty-five presacral vertebrae, definitely shown in specimen No. 177. This is the number found by Case in *Captorhinus*, and one less than the number in *Limnoscelis*, a genus which has not a few points of resemblance to *Labidosaurus*. It is two more than is possessed by *Seymouria*, and three or four more than in *Diadectes*. In *Pantylus* the number is unknown.

The postaxial, presacral vertebrae are scarcely distinguishable from each other, except the five posterior ones, which have no processes for rib articulation. The spines anteriorly are a little more slender, giving greater freedom of vertical movement. The transverse processes anteriorly are a little longer, standing out beyond the margin of the zygapophyses; they are also a little stouter here, extending down farther on the sides of the centrum. The intercentra anteriorly are small, not nearly filling out the space between the margins of the centra. There are two sacral vertebrae; the first bears a stout rib, with a broad, vertical face, as long as the centrum, for articulation with the ilium; the second has a much smaller rib, only touching the ilium behind and below the first rib. The caudal vertebrae, so far as known, are narrower than the presacral, and have more slender processes. Their ribs are co-ossified with the centra, unlike those of *Seymouria*.

The first and second ribs are slender; the third is broader and much longer. The fourth, as in *Captorhinus*, is remarkable (Fig. 1) and would hardly be recognized as a rib if found isolated. Its length is less than three times the width of the distal end. It is narrowed in the middle and much expanded at its extremities. Like the early ribs of *Seymouria*, *Diadectes*, and *Limnoscelis*, its function was the support of the scapula.

*Pectoral girdle* (Figs. 5, 6).—In five different specimens, the pectoral girdle, more or less complete, is found in position with the skull and but slightly dislocated from its association with the vertebral column. In each case the front end of the interclavicle with its articulated clavicles lies between the angles of the jaws and immediately under the occipital condyle—precisely its position in the temnospondylous amphibians and in *Diplocaulus*. There was literally no neck in the cotylosaurs. In three of these specimens the shaft of the clavicles is turned dorsad at a right angle to the lower, horizontal, and expanded part; in two or three others the angle is slightly greater. In one specimen, that shown in Fig. 1, lying in immediate connection with the upper end of the clavicle, there is a very slender bone about 20 mm. in length; a similar bone is also found in specimen No. 178 with quite the same relations. There would seem to be little doubt that it is a vestigial cleithrum. In *Limnoscelis* the cleithrum is very small, though much larger in *Diadectes*. None has been observed in *Seymouria*, but I am inclined to believe that all the American cotylosaurs possessed the element, though in some cases it was vestigial. The scapula figured (Fig. 5, *E*), is quite complete, but is lying on its

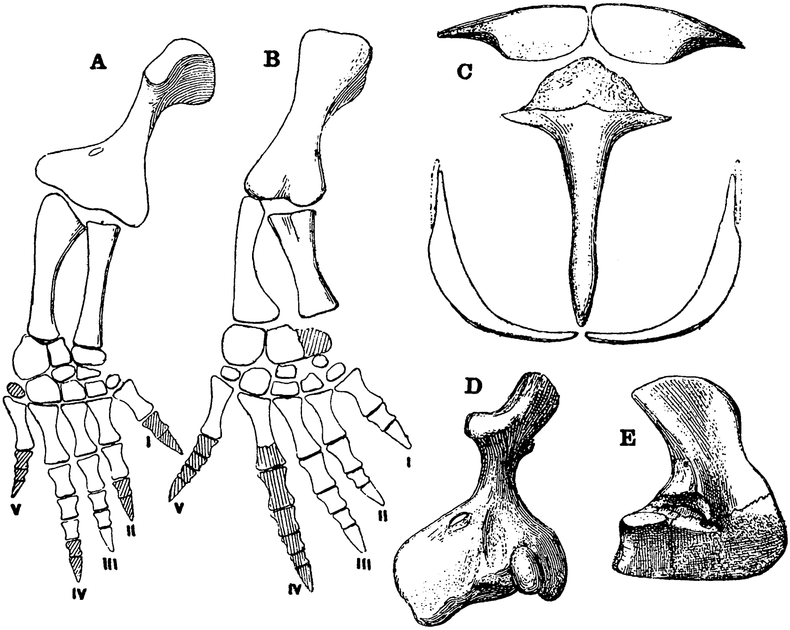

FIG. 5.—*Labidosaurus*. *A*, front leg; *B*, hind leg; *C*, clavicular girdle clavicles from below, interclavicle from below, clavicles from in front; *D*, humerus ventral face; *E*, scapula, outer face (No. 634). All figures about one-half natural size.

side and has suffered a lateral compression. In specimen No. 178 (Fig. 6) the scapulae lie almost perfectly in position with the clavicular girdle, or at least that of the left side. The blade may have been pressed outwardly a little, but the angle between it and the horizontal coracoids is nearly rectangular. As a whole, the scapula is rather broad and short, as in *Limnoscelis*, a little narrower in the larger specimen. The sutures separating the coracoids and the scapula have been corroborated in several specimens.

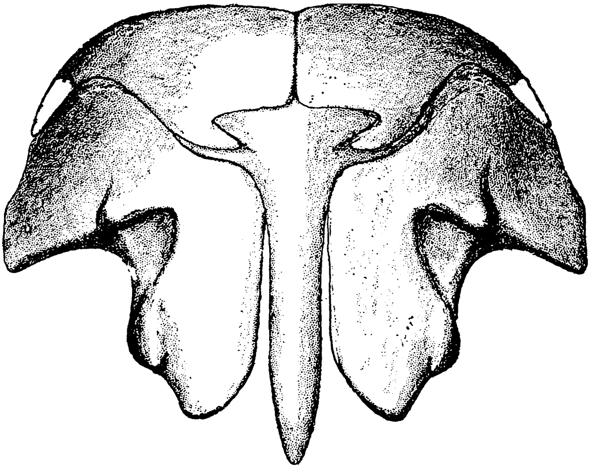

FIG. 6.—*Labidosaurus*. No. 178. Pectoral girdle, from below. One-half natural size.

*Forelegs*.—The humeri of the different specimens vary appreciably in shape, but I do not know the value of the differences. They have a greatly expanded distal end, as would be called for by the large and stout hand. The radius and ulna are shown connected in three specimens. They are somewhat more slender than the posterior epipodials, and are much shorter than the humerus.

The carpus was correctly figured by me in my earliest paper; unfortunately some of the bones were incorrectly identified: it is the fifth and not the first digit which was missing. There are definitely four phalanges in the third finger, and there can be little, if any, doubt that the formula was the primitive one of 2, 3, 4, 5, 3. The fifth carpale I have not recognized, but it doubtless was ossified.

*Pelvis.*—Of the pelvis the ilium is not visible in its entirety in any specimen. In the restoration I have borrowed from Broili's figure the outline of the upper part articulating with the sacral ribs. The flat, platelike pubes and ischia are firmly united in the middle, with no opening except the usual obturator foramen; they are proportionally long.

*Hind legs.*—The femur has been well figured by Case. It is rather short and stout, much stouter than in *Captorhinus*. The tibia is unusually stout, and the fibula is much curved; both bones are much shorter than the femur. My original figure of the tarsus was erroneous in several particulars, as was suggested by Jaekel. Most of the tarsal bones have been correctly figured by Case. In one specimen (No. 174) I find what I believe to be evidence of two centralia, as in *Ophiacodon*, though Case figures but one. The phalangeal formula was doubtless 2, 3, 4, 5, 4. The first three digits are shown in the figure (Fig. 1). The first digit of both the hand and the foot is relatively large, and its metapodial was capable of but little divarication from the others. The fifth metapodial was but little shorter than the fourth.

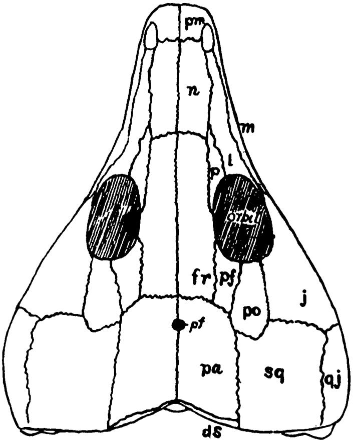

FIG. 7.—*Labidosaurus.* Outline of skull, from above: *pm*, premaxilla; *n*, nasal; *m*, maxilla; *l*, lacrimal; *p*, prefrontal; *fr*, frontal; *pf*, postfrontal; *po*, postorbital; *j*, jugal; *pa*, parietal; *sq*, squamosal;, *ds*, dermosupraoccipital; *pf*, parietal foramen. (Engraving from *Water Reptiles*, p. 22, Fig. 6.)

Parenthetically I may add that I do not at all agree with Goodrich[1] in imputing to the form and position of the fifth toe so much importance in the classification and phylogeny of the reptiles. The divarication and hook shape of the fifth metatarsal have been due, I believe, to modifications of the tarsus and doubtless have arisen homoplastically in various lines of descent. In all primitive reptiles there was a fifth tarsale. As has been amply proved, I think, the bone has absolutely disappeared in all modern amniotes, leaving a space that was soon occupied by the proximal end of the fifth metatarsal, which came to articulate directly with the large fourth tarsale. In many Permian reptiles a divarication and proximal elongation of the fifth metatarsal had begun. This change in the articulation, it seems to me, will easily account for the change in the form of the fifth metatarsal in crawling plantigrade reptiles. In the rectigrade, and more ambulatory reptiles, on the other hand, with less functional use of the fifth toe, the metatarsal retained more of its primitive shape and position parallel with the fourth, especially in the forms ancestral to the mammals.

---

[1] *Proc. Royal Soc.*, LXXXIX (1916), 261.

The chief fallacy in Goodrich's arguments lies in deriving the stegocrotaphous chelonian skull from a single- or double-arched ancestor because of the shape of the fifth metatarsal. It is now conceded that the turtles must have had a direct ancestry from the cotylosaurian type of reptile; if so. the hook-shaped metatarsal must have been an independent acquirement.

The hands and feet of *Labidosaurus* (Fig. 5) are relatively large and powerful, the foot nearly as long as the leg, the hand as the arm. The first digit of each is relatively large and but little divaricated in life; its

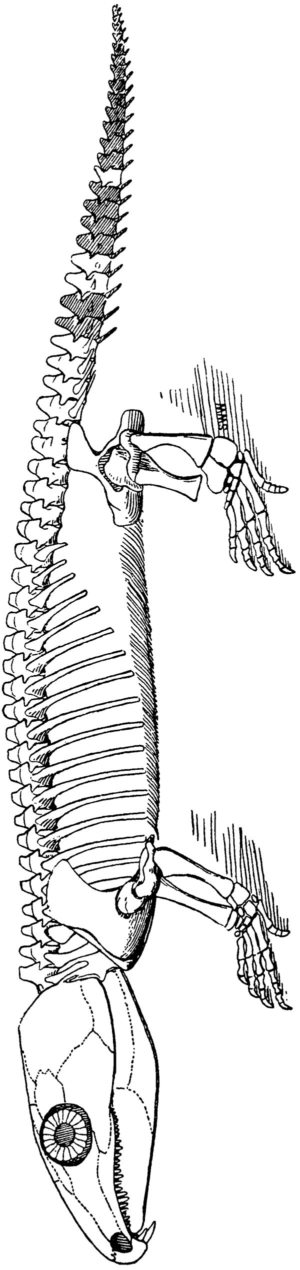

FIG. 8.—*Labidosaurus.* Skeleton. About one-fourth natural size

metapodial is but little smaller than the second. The metapodials are all stout, but the digits are short, tapering rapidly. The ungual phalanges are more pointed than in either *Limnoscelis* or *Diadectes;* the fifth tarsale, as usual, is small.

Very slender ventral ribs, for the first time recognized in this genus among the cotylosaurs, are present in numerous specimens. So far as they are preserved, they do not seem to differ from those of *Ophiacodon* or *Varanops*, for instance. It is pretty certain that they are absent in the diadectids and *Limnoscelis*. Why some genera in each order of reptiles should have retained these bones, while others lost them, I am not prepared to hazard a guess. Possibly they have something to do with water habits.

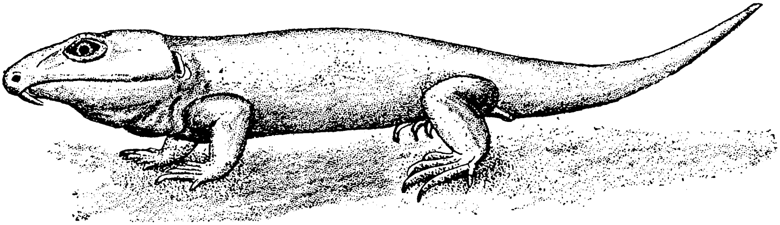

FIG. 9.—*Labidosaurus*. Life restoration, about one-eighth natural size

*Restoration* (Figs. 8 and 9).—The only attempt that has hitherto been made at the restoration of the skeleton of *Labidosaurus* is that of Broili, which was quite acceptable, considering our little knowledge of the genus and its allies at the time he made it. That he placed the front legs so far back as he did, is not surprising; almost anyone would have done likewise at the time; and in the curvature of the vertebral column he was unduly influenced by the erroneous early restorations of *Pareiasaurus*, at that time supposed to be a near relative. I may only remark here that the present restoration, based as it is upon so much material, has scarcely anything conjectural about it, or anything that has not been corroborated by several specimens. As usual, the length of the tail is still in doubt. I have assumed that it was about as long as in the allied captorhinids, of which we know the tail more definitely.

*Habits.*—Granted a fairly complete knowledge of the osseous structure of such early reptiles, there must remain more or less conjecture as to how and where the creatures lived. The two striking characters seen in the skeleton are the elongated, hooklike incisor teeth and the very powerful feet. Were they correlated? I believe that they were. There is no evidence that the powerful feet were developed for use in swimming, though doubtless the creatures swam well. Nor is there any evidence that the creatures used them for digging holes in which to crawl, for the very good reason that the front legs were altogether too short; they could not have scratched their own noses, much less dig holes for the body to enter. Why not then assume that the feet were developed for digging for food? The epipodials are relatively short, a character constantly found in animals using their legs for propulsion in the water. But why not the same shortening to give greater immediate power in digging? I believe, then, that *Labidosaurus* lived about the lowlands, on the borders of the seas or lakes, and found its livelihood in extricating worms and larvae from the rocks or soil, for which the long, hooklike front teeth were admirably fitted. The posterior teeth in *Labidosaurus* were not strictly carnivorous; they were better adapted for cutting than for tearing or seizing. They are flattened, with an obtusely pointed apex; and the palatine teeth were very small, except those of the "transpalatine" part of the pterygoids. The motion of the head upon the shoulders was limited laterally, rather free vertically. The trunk was not very flexible. The spines were short, but the great development of the arches of the vertebrae furnished ample place for the attachment of muscles controlling the head. Finally, in motion the animal must have been slow and sluggish.

In some respects *Labidosaurus* is the most specialized of all the American cotylosaurs, especially in the loss of the supratemporal and tabular bones, rarely absent in other cotylosaurs; and in the reduction of the dermosupraoccipitals, and their restriction to the occipital surface of the skull. The genus could not have been ancestral to any known later cotylosaurs, though possibly the Captorhinidae may have been allied to the ancestral stock of the Procolophonia of the Trias.